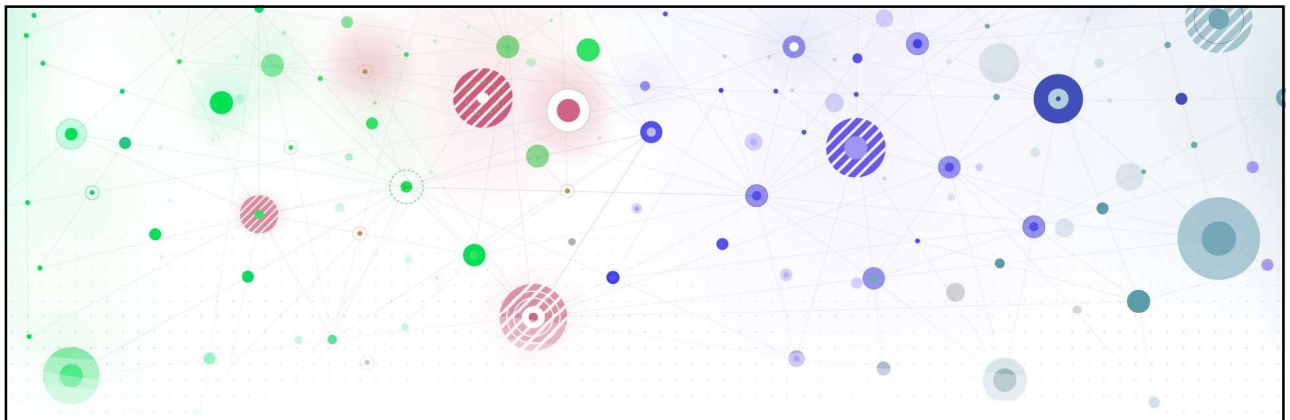


MODULE 4
OPERATOR OVERLOADING

Operator Overloading

- It is possible to overload the built-in C++ operators such as **+**, **>=**, and **++** so that they invoke different functions, depending on their operands.
- **a+b** will call one function if **a** and **b** are integers, but will call a different function if **a** and **b** are objects of a class.
- Operator overloading makes your program easier to write and to understand.
- Overloading does not actually add any capabilities to C++.
  - Everything you can do with an overloaded operator you can also do with a function.
  - However, overloaded operators make your programs easier to write, read, and maintain.

Operator Overloading

- Operator overloading is only another way of calling a function.
- You have no reason to overload an operator except if it will make the code involving your class easier to write and especially easier to read.
- Remember that code is read much more than it is written

Limitations

- You can't overload operators that don't already exist in C++. You can overload only the built-in operators.
- You can not overload the following operators
  - `.`
  - `*`
  - `->`
  - `,`
  - `::`
  - `?:`
  - `sizeof`

Limitations

- The C++ operators can be divided roughly into binary and unary. Binary operators take two arguments. Examples are a+b, a-b, a/b, and so on. Unary operators take only one argument: -a, ++a, a--.
- If a built-in operator is binary, then all overloads of it remain binary. It is also true for unary operators.
- Operator precedence and syntax (number of arguments) cannot be changed through overloading.
- All the operators used in expressions that contain only built-in data types cannot be changed. At least one operand must be of a user defined type (class).

Overloading the + operator for TComplex

```
class TComplex {
    float real,img;
  public:
    :   // Member functions
    TComplex operator+(TComplex&);
};
// The Body of the function for operator + TComplex
TComplex::operator+(TComplex& this, TComplex& z) {
   TComplex result;
   result.real = this->real + z.real;
   result.img = this->img + z.img;
   return result;
}
```

Overloading the + operator for TComplex

```
TComplex::operator-(TComplex& this) {
    TComplex result;
    result.real = -this->real;
    result.img = -this->img;
    return result;
}
```

Overloading the + operator for TComplex

```
int main() {
    TComplex z1,z2,z3,z4;
     :     // Other operations
     z3=z1+z2; // like z3 = z1.operator+(z2);
     z4=-z3; // like z4 = z3.operator-();
}
```

Overloading the Assignment Operator (=)

> Because assigning an object to another object of the same type is an activity most people expect to be possible, the compiler will ***automatically*** create a

```
type::operator=(const type &)
```

if you don't make one.

> The behavior of this operator is member wise assignment.

– It assigns (copies) each member of an object to members of another object. (***Shallow Copy***)

– If this operation is sufficient you don't need to overload the assignment operator.

- For example, overloading of assignment operator for complex numbers is **not** necessary.

Overloading the Assignment Operator (=)

```
void TComplex::operator=(const TComplex& z){
    real = z.real;
    img = z.img;
}
```

> You don't need to write such an assignment operator function, because the operator provided by the compiler does the same thing.

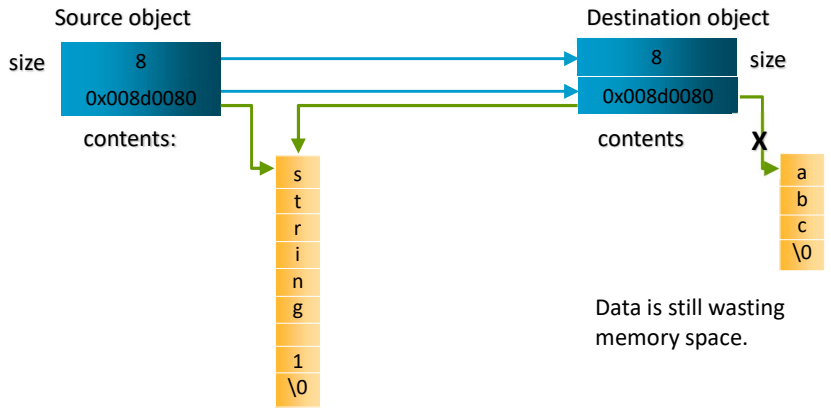
Overloading the Assignment Operator (=)

- In general, you don't want to let the compiler do this for you.
- With classes of any sophistication (especially if they contain pointers!) you want to explicitly create an **operator=**.

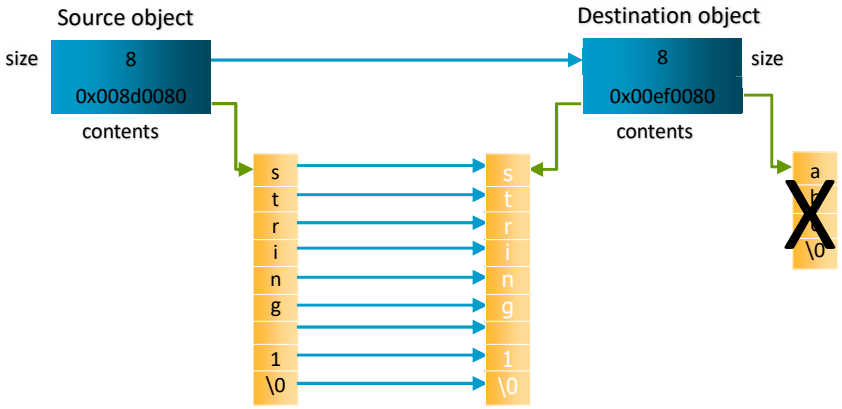
Example

```
class string {
   int size;
   char *contents;
 public:
   void operator=(const string &);
   :         // Other methods
};
void string::operator=(const string &s) {
   size = s.size;
   delete []contents;
   contents = new char[size+1];
   strcpy(contents, s.contents);
}
```

Operator Provided by the Compiler



Operator of the Programmer



Return value of the assignment operator

> When there's a void return value, you can't ***chain*** the assignment operator (as in `a = b = c`).

> To fix this, the assignment operator must return a reference to the object that called the operator function (its address).

```
const String& String::operator=(const String &s)  {
   if (this->size != s.size){
        this->size = s.size;
        delete [] this->contents;
        this->contents = new char[size+1];
   }
   strcpy(this->contents, s.contents);
   return *this;
}
```

Copy Constructor *vs*. Assignment Operator

> The difference between the assignment operator and the copy constructor is

– The copy constructor actually creates a new object before copying data from another object into it

– The assignment operator copies data into an already existing object.

Copy Constructor *vs*. Assignment Operator

Assume that A is an ordinary class

> `A a;`

Default constructor

> `A b(a);`

Copy constructor

> `b=a;`

Assignment operator

> `A c=a;`

Copy constructor

Overloading Unary Operators

> Unary operators operate on a single operand. Examples are the increment (`++`) and decrement (`--`) operators; the unary minus, as in `-5`; and the logical not (`!`) operator.

> Unary operators take no arguments, they operate on the object for which they were called.

> Normally, this operator appears on the left side of the object, as in `!obj`, `-obj`, and `++obj`.

Overloading Unary Operators

> **Example**:

We define ++ operator for class **TComplex** to increment the real part of the complex number by 0.1 .

```
void TComplex::operator++() {
      real=real+0.1;
}
int main() {
     TComplex z(1.2, 0.5);
     ++z;  // operator++ function is called
     z.print();
     return 0;
}
```

Overloading Unary Operators

> To be able to assign the incremented value to a new object, the operator function must return a reference to the object.

```
// ++ operator
const TComplex& TComplex::operator++(){
      real=real+0.1;
      return *this;
}
int main()  {
     TComplex z1(1.2, 0.5), z2;
     z2 = ++z1;
     z2.print();
     return 0;
}
```

Overloading the "[]" Operator

- Same rules apply to all operators. So we don't need to discuss each operator. However, we will examine some interesting operators.
- One of the interesting operators is the ***subscript operator***.
- It can be declared in two different ways:

```
class C {
  returntype & operator [] (paramtype);
      or
  const returntype & operator [] (paramtype) const;
};
```

Overloading the "[]" Operator

- The first declaration can be used when the overloaded subscript operator modifies the object.
- The second declaration is used with a const object; in this case, the overloaded subscript operator can access but not modify the object.
- If c is an object of class C, the expression

```
c[i]
```

- is interpreted as

```
c.operator[ ](i)
```

> Example: Overloading of the subscript operator for the **String** class. The operator will be used to access the **i**th character of the string. If **i** is less than zero then the first character and if **i** is greater than the size of the string the last character will be accessed.

```
char & String::operator[](int i) {
    if(i < 0) return contents[0];
    if(i >= size) return contents[size-1];
    return contents[i];
}
int main()  {
    String s1("String 1");
    s1[1] = 'p';
    s1.print();
    cout << "5th character: " << s1[5] << endl;
    return 0;
}
```

Overloading the " ( ) " Operator

> The function call operator is unique in that it allows any number of arguments

```
class C{
    returnType operator( )(paramTypes);
};
```

> If c is an object of class C, the expression `c(i,j,k)` is interpreted as

```
c.operator()(i,j,k)
```

Example

> The function call operator is overloaded to print complex numbers on the screen. In this example the function call operator does not take any arguments.

```
void TComplex::operator()() const {
    cout << real << " , " << img <<  endl ;
}
```

Example

> The function call operator is overloaded to copy a part of the contents of a **String** into a given memory location.

> In this example the function call operator takes two arguments: the address of the destination memory and the numbers of characters to copy.

```
void String::operator()(char *dest,int num) const {
    if (num > size) num=size;
    for (int k=0; k < num; k++)
        dest[k]=contents[k];
}
```

Example

```
void String::operator()(char *dest,int num) const {
    if (num > size) num=size;
    for (int k=0; k < num; k++)
        dest[k]=contents[k];
}
int main( ) {
    String s1("Example Program");
    char * c = new char[8];
    s1(c,7);
    c[7] = '\0';
    cout << c;
    delete [] c;
    return 0;
}
```

"Pre" & "post" form of operators ++ and --

- Recall that **++** and **--** operators come in "***pre***" and "***post***" form.
- If these operators are used with an assignment statement than different forms has different meanings.

```
z2= ++z1;      // preincrement
z2 = z1++;      // postincrement
```

- The declaration, **operator++()** with no parameters overloads the ***pre*increment** operator.
- The declaration, **operator++(int)** with a single **int** parameter overloads the post-increment operator. Here, the **int** parameter serves to distinguish the ***post*increment** form from the ***pre*increment** form. This parameter is **not used**.

Post-Increment Operator

```
// post-increment operator
TComplex TComplex::operator++(int) {
  TComplex temp;
  temp= *this;    //old value
  real= real+0.1; //increment the real part
  return temp; //return old value
}
```

Pre-Increment Operator

```
// pre-increment operator
TComplex TComplex::operator++() {
  real= real + 0.1; // increment real part
  return *this; // return new value
}
```